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Who Do Consumers Trust for Information: The Case of Genetically Modified Foods?

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During the twentieth century, research and development (R&D) has produced a steady stream of inventions and new consumer goods, many of which have been adopted and proven to be the source of a rising standard of living (Boskin et al.). The introduction of new goods, however, creates a disequilibrium (Hausman), which in turn creates a demand by economic agents for objective information to assist in making decisions on adoption and use (Schultz).[1] The consumer's challenge is to sort through the various, competing and sometimes conflicting, sources of information.

Consider, for example, the controversial products—genetically modified (GM) foods. The agricultural biotechnology firms (e.g., Monsanto, Syngenta, and the industry's Council on Biotechnology Information) have hailed the use of biotechnology to create new products as a major revolution in product innovation (Hoban 1997, 2001). They have disseminated information claiming that GM crops will lower food costs worldwide and improve environmental quality. The council has even created and distributed children's coloring books that promote the positive aspects of GM foods.

In contrast, two international environmental NGOs, Greenpeace and Friends of the Earth, have distributed negative information through web sites, press releases, and demonstrated claiming risks to human health, environment, and biodiversity. They also claim that consumers have the right to know with respect to GM labeling, and that new technology benefits only large multinationals and not consumers (Friends of the Earth, Greenpeace International 1997). The federal government also supplies information on genetic modification. In 1992, the Food and Drug Administration (FDA) issued a statement saying that GM foods do not have to be labeled if the new product has the same characteristics as its non-GM counterpart (FDA 1992). If, however, a new vitamin was introduced into a food crop using genetic modification, the food product would have to be labeled (FDA 2001). In contrast, Australia, China, European Union (EU), Mexico, New Zealand, and Russia have mandatory labeling policies for GM foods. In 2004, the EU removed a four-year moratorium on approvals of GM crops, but in April it implemented traceability requirement for food and feed.

In principle, society can recapture some of the losses from diverse information disseminated by interested parties if decision makers have access to independent, third-party information. For example, see the discussion of verifiable information in Milgrom and Roberts and Huffman and Tegene. In recent research, Huffman et al. have defined

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[1] The appearance of new goods (or new attributes) has the same effect that the appearance of a new means of production has on a firm (Bianchi; Becker 1976, pp. 131–149).

verifiable information for genetic modification as information that is from a knowledgeable independent, third-party source that has no significant financial ties to the agricultural biotechnology industry. Although government agencies provide information, we do not claim that federal government agencies present an independent, third-party perspective. Federal regulatory agencies do not have the resources required to engage in significant independent research, and they must rely heavily upon the firms that they regulate to provide them the information they use to make recommendations. Although biotech firms are not always pleased with decisions made by the FDA, USDA, or EPA, the international NGOs believe that these agencies have a decidedly probiotech perspective (Greenpeace International 1997, 2002; Gates). Also, elected government officials may receive campaign contributions from interested parties who are hoping to obtain future favorable treatment. Consequently, Huffman and Tegene have proposed that a quasi-governmental agency, that is funded, perhaps by the federal government, but not controlled by government officials, would be the most credible source of independent, third-party information on genetic modification. Rousu et al. have concluded that verifiable information on GM food products can have an annual value to U.S. consumers of over $2 billion annually.

Interested and disinterested parties disseminate information with the goal of affecting consumers' (and producers') decisions on GM technology and other products. However, for these groups to be influential, they must garner "trust." Recent evidence by Glaeser et al. shows that individuals who are closer in social status or who have similar personal capital (PC) are more likely to trust one another. For example, individuals who were raised with a particular religious tradition place more trust in others who were raised within the same religious tradition, *ceteris paribus*. More generally, Becker (1996) argues that consumer's social captial (SC) and PC are important determinants of his/her tastes or preferences. Social capital is defined as the capital the individual acquires through his or her surroundings, upbringing, and social network. Personal/human capital is defined as capital that the individual personally acquires, such as, schooling, habits, or experience. Becker shows when PC and SC are incorporated into economic models, economic theory can explain many previously puzzling outcomes such as the effect of advertising on consumers' purchasing behavior and human addictions.

Understanding the formation of trust in information sources is an important step in understanding consumers' preferences for information on new products. With the aid of a model, we formulate hypotheses about the role of measurable attributes of a consumer, which are related to his or her household income, PC and SC, and prior beliefs in the formation of trust. For this study, unique data were collected by an independent agency from a random sample of adults chosen from two major Midwestern cities.[2] These individuals were paid $40 to come to a central location, to provide sociodemographic information and information on prior beliefs about technologies, and to participate in a set of experiments (as explained in detail in a companion paper, Huffman et al.). At the end of the experiments, they were asked to complete a short questionnaire including the following question: "If a source of information were to give you verifiable information on GM foods, who would you trust most?" This information was coded into six different categories: third party, government, environmental or consumer group, private industry or organization, none or nobody, and "other" (including no response). A multinomial logit model is fitted to the sample of postexperiment participants to explain their relative trust in sources to provide verifiable information on GM foods.

We find an individual's household income has no significant effect on relative trust, but an increase in his or her schooling lowers the probability of trusting information from government, private industry or organizations, environmental or consumer groups, or "other" sources relative to information from an independent third-party source. Older individuals have significantly lower odds of trusting "nobody" for GM information relative to an independent, third-party source. People who claimed to be informed about genetic modification before the experiments were more likely to trust the government than the third-party sources. People who had a conservative religious upbringing had a lower odds of

[2] A telephone interview of a random sample of adults is an alternative route to obtaining observations and data. See for example, Johnston et al. who undertake a contingent-choice telephone survey of a national sample of households. Contingent valuation has the well-known shortcoming of asking only "hypothetical questions" rather than budget-constrained questions. Our laboratory auction market required participants to "pay" what they "say," that is, bids are real. Because of major costs of getting participants to a laboratory location and setting up experiments and paying participants, a laboratory auction can be conducted in only few locations and with a modest number of participants. We have a total of 318 individuals participant, which large by experimental economics standards.

trusting private industry or organizations and a higher odds of trusting "nobody" relative to an independent, third-party source. This article has five sections.

Model

Following Becker (1996), consider the strictly quasi-concave utility function shown as:

$$U = U(X_l, X_{pl}; T_1, \ldots, T_j). \tag{1}$$

Utility is based on the consumption of two choice variables: foods labeled as GM (X_l) and foods that have a plain label (X_{pl}). The utility of these two goods is hypothesized to be affected by information from j sources. This information differs in quality for each type (i.e., level of trust). Assume information quality or trust in the jth type is a function of the consumer's PC and SC:

$$T_j = f_j(SC, PC). \tag{2}$$

The market price for foods labeled as GM is p_l and the price of plain-labeled foods is p_{pl}. At time t, the consumer maximizes his or her utility, subject to the budget constraint M, and stock of PC and SC:

$$\max U(X_l, X_{pl}, T_1, \ldots, T_J), \quad T_j = f_j(SC, PC) \quad \text{s.t. } p_l X_l + p_{pl} X_{pl} \le M. \tag{3}$$

The first-order conditions are as follows:

$$MU_l(X_l, X_{pl}; T_1, \ldots, T_J) - \lambda p_l = 0 \tag{4}$$

$$MU_{nl}(X_l, X_{pl}; T_1, \ldots, T_J) - \lambda p_{pl} = 0 \tag{5}$$

$$p_l X_l + p_{pl} X_{pl} - M = 0. \tag{6}$$

Equations (5) and (6) can be rearranged to show the marginal rate of substitution between GM- and plain-labeled foods, as shown in equation (7):

$$\frac{MU_l(X_l, X_{pl}; T_1, \ldots, T_J)}{MU_{pl}(X_l, X_{pl}; T_1, \ldots, T_J)} = \frac{p_l}{p_{pl}}. \tag{7}$$

A consumer's marginal rate of substitution between GM- and plain-labeled foods is a function of the relative prices of the goods and PC and SC, which influences the trust for the j providers of information. By moving the ratio of prices to the left-hand side, we can differentiate with respect to PC or SC. Consider the equation below, which examines the impact of a change in a consumer's PC for the two goods:

$$\frac{MU_{pl}(\cdot)\left(\sum_{j=1}^{J} \frac{\partial MU_l(\cdot)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right) - MU_l(\cdot)\left(\sum_{j=1}^{J} \frac{\partial MU_{pl}(\cdot)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right)}{[MU_{pl}(\cdot)]^2}. \tag{8}$$

A change in PC seems likely to have differential impacts across the j information quality types and is not neutral on the marginal rate of substitution between GM- and plain-labeled foods. To simplify the analysis and without loss of generality, assume a change in T_j, $j = 1, \ldots, J$, does not impact the marginal utility for plain-labeled (non-GM) foods. Then, equation (8) becomes

$$\frac{MU_{pl}(\cdot)\left(\sum_{j=1}^{J} \frac{\partial MU_l(\cdot)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right)}{[MU_{pl}(\cdot)]^2}. \tag{9}$$

Now if an increase in an individual's PC reduces his or her trust in agri-business information which then lowers his or her marginal utility of GM-labeled food, this causes the consumer's marginal rate of substitution between GM- and plain-labeled foods to decrease. Hence, the consumer will purchase more plain-labeled foods at given relative prices. This example illustrates that, when an individual's PC (or SC) changes his or her trust in an interested party (by changing the perceived quality of the information), it can affect consumer's demand for GM- and plain-labeled foods.

The Survey

The participants in our postexperiment survey were adult consumers over eighteen years of age chosen by a random digit-dialing method from two major Midwestern metropolitan areas (Tegene et al.). Three hundred eighteen individuals participated in our project out of 1,673 contacted, which was a response rate of approximately 19%. When individuals arrived at the lab site, they were asked to complete a preauction questionnaire giving sociodemographic information and information about prior knowledge on GM technology. After the laboratory experiments were completed, they then completed a postauction questionnaire. This questionnaire included the

Table 1. Attributes of the Sample ($N = 318$)

		Number	Percentage
Panel A. "Who Individuals Trust for Information on Genetic Modification"			
All		318	100
Third party including university, scientists/researchers		94	29.6
Government		62	19.5
Environmental or consumer group		12	3.8
Private industry or organization		16	5
None or nobody		19	6
Other, media, or no answer		115	36.1
Variables	Definition	Mean	SD
Panel B. Attributes of Participants			
Income	household's annual income ($1,000)	54.70	34.10
Education	years of form schooling completed	14.50	4.50
Age	the participant's age	50.10	17.50
Gender	1 if female, and 0 for male	0.62	0.49
Informed	1 if participant considered him/herself at least somewhat about GM preexperiment	0.48	0.44
Religion	1 if conservative religious upbringing	0.59	0.25

question: "If a source were to give you verifiable information on GM foods, who would you trust most?"[3] This was an open-ended question, and participants wrote their answer down on the questionnaire. "We then arbitrarily coded the responses into six categories": government; university, scientists/researchers, or third-party groups; environmental or consumer group; private industry or organization; none or nobody; and "other," including media.

The first category is independent third-party sources. It contains responses from individuals who would most trust universities, scientists, or an independent third-party group that does not have financial ties to genetic modification. The second category "government" contains responses from individuals who named a government (national, state, or local) or a governmental entity (e.g., FDA). The third category "environmental or consumer group" is for participants who indicated they would most trust an environmental or a consumer group to provide verifiable information on GM foods. The fourth category is "private industry or organizations," which contains the response for any individual who listed a private entity or business as the group they would trust most. Most of these responses were for agri-business firms or grocery stores. The fifth category is "none or no body" and it is for individuals who said they would not trust any source. The last category is classified as "other," and it contains responses by individuals who would trust the media, and some responses that were too sparse for their own category (e.g., one person said he or she most trusted God to provide verifiable information on GM foods).

Excluding the "other" category, the most frequently reported trusted source for information on genetic modification the first group, "third-party including university, scientists/researches," accounting for 30% of the responses (see table 1, panel A). The "government" was listed by 20% of the respondents. The "environmental or consumer group," "private industry or organizations," and "none" each received less than 6% of the responses. The media is included in a residual category that includes "other" preferences.

Although the demographics of our sample do not perfectly match the U.S. Census demographic characteristics for these regions, they are similar and provide a sufficient representation to examine which consumers trust for information on GM foods (see Tegene et al.). Our participants were slightly skewed toward women, but Katsaras et al. show that women make up a disproportional share of grocery shoppers—83% of shoppers versus 52% in the U.S. Census of Population.

Personal capital is proxied by an individual's education, age, and prior knowledge about GM technology. An individual's education not

[3] To see the format of these experiments, see Huffman et al. or Tegene et al.

only affects his or her opportunity cost of his or her time, but also his or her ability to acquire and process information, to make decisions (Schultz, Huffman), and formulate trust. Twenty-five percent of the participants had not gone beyond high school. About 39% of the participants had completed four or more years of college.

An individual's age is a proxy for years of experience as a decision maker, which is expected to affect the formation of trust, and also an indicator of length of expected remaining length of life. As an individual becomes older, he or she has fewer expected years over which to obtain benefits from acquired information.

If a participant is "informed" about genetic modification before the experiment, this may affect his or her preferences for information sources. Being "Informed" is represented as dummy variable taking a value of 1 if the respondent perceives him or herself as being "at least somewhat informed regarding GM foods."

Religious upbringing is a form of SC, and, hence, could play a role in trust formation. Our survey asked people to indicate their religious affiliation when they were young. Fifteen percent of the participants were raised as Baptists, slightly more than 26% of participants were raised as Catholics, and about 17% were raised as Lutherans. Forty-seven percent had other affiliations. Individuals were designated as having a "conservative" religious upbringing relative to "trust" in information sources for GM food if they were raised as Baptists, Catholic, or Lutheran. These three religions have among the strictest religious upbringings on the origin of life. See panel B of table 1 for sample means of these variables.

Econometric Model

Consider a random indirect utility model in which the utility of a consumer's choice j is determined by x_j, consumer's household income, goods' prices, and attributes:

$$U_{ij} = \beta' x_{ij} + \varepsilon_{ij}. \tag{10}$$

The utility of consumer i is based on information choice $j \in J$. If he or she chooses j, it must be the one yielding the highest utility. When disturbance terms are independently and identically distributed Weibull, the probability of consumer i choosing source j is

$$\text{Prob}(Y_i = j) = e^{\beta_j' x_i} \Big/ \sum_{k=1}^{J} e^{\beta_k' x_{ii}} \quad \text{for } j = 0, 1, \ldots, J. \tag{11}$$

Equation (11) is the multinomial logit model (see Greene, p. 720–22). To solve the model, however, one must first define $\beta_j^* = \beta_j + q$, for a vector $\mathbf{q}$, and then normalize $\beta_0 = 0$.[4] The probability of choosing source j is then

$$\text{Prob}(Y = j) = e^{\beta_j' x_i} \Big/ \left(1 + \sum_{k=1}^{J} e^{\beta_k' x_{ii}}\right) \quad \text{for } j = 1, 2, \ldots, J \tag{12}$$

$$\text{Prob}(Y = 0) = 1 \Big/ \left(1 + \sum_{k=1}^{J} e^{\beta_k' x_{ii}}\right). \tag{13}$$

We can represent the probability a consumer prefers source j ($j = 1, \ldots, J$) as the log-odds ratios:

$$\ln(P_{ij}/P_{i0}) = \beta_j' x_i. \tag{14}$$

Equation (14) shows the probability that a consumer prefers (trust) source j over choice 0, the reference choice.[5] If β_j' is positive, then a marginal increase in x_i increases the odds that the consumer prefers source j over the reference source 0, which is the "independent third-party source." The regressors are variables proxying an individual's PC and SC, his or her beliefs, and his or her household income.

Econometric Results

The fitted model provides empirical evidence for the odds that a consumer trusts one of the five sources of information more or less than he or she trusts an "independent third-party source" to provide verifiable information on GM foods. Five regressors were included in this multinomial logit model: a participant's household income, education, age (which can be thought of as a proxy for experience), a

[4] This arises because the alternatives are mutually exclusive and exhaustive and the associated probabilities sum to 1. Only J parameter vectors are needed to determine the $(J + 1)$ probabilities.

[5] From the point of view of estimation, it is a major advantage that the odds ratio does not depend on the other choices, which follows from the independence of disturbances in the original model. From a behavioral viewpoint, however, this fact is not so attractive.

Table 2. Estimates of Multinomial Logit Model: Who Would You Trust to Provide Verifiable Information on Genetically Modified Foods? ($N = 318$)

Variable	Government/ Third Party	Env. or Con. Group/Third Party	Private Ind. or Org./Third Party	Nobody/ Third Party	Other/ Third Party
Intercept	1.169	−1.658	2.369	4.043*	5.568***
	(1.286)	(2.420)	(2.172)	(1.810)	(1.141)
Household income	−0.0010	−0.0099	0.0076	−0.0100	0.0017
	(0.0052)	(0.0110)	(0.0085)	(0.0096)	(0.0046)
Education	−0.138*	0.081	−0.347**	−0.242*	−0.389***
	(0.080)	(0.149)	(0.147)	(0.124)	(0.074)
Age	0.010	−0.025	0.001	−0.035**	0.004
	(0.010)	(0.019)	(0.017)	(0.016)	(0.009)
Informed	0.344**	0.442	0.003	0.050	0.158
	(0.170)	(0.328)	(0.286)	(0.269)	(0.149)
Religious upbringing	−0.042	0.055	−0.840**	0.556**	−0.074
	(0.171)	(0.316)	(0.399)	(0.280)	(0.151)

*Indicates that an estimated coefficient is significantly different from zero at the 10% level.
**At the 5% significance level.
***At the 1% level.
Note: The reference group is an independent, third-party source, and standard errors are in parentheses.

dummy variable for prior beliefs, and a dummy for conservative religious affiliation.

The maximum likelihood estimates of the coefficients for the multinomial logit model for an individual's relative trust in information sources are reported in table 2. The independent variables are listed on the far-left column in table 2, while the information sources are listed along the top. Increasing a participant's household income did not change the odds of choosing any of the five sources relative to third-party information, and hence, was excluded in the final fitting. Income may increase the demand for information of all types equally (or not at all). An individual who is well educated is shown to more likely to trust an "independent third-party" source relative to the other five sources. Also, increasing a participant's schooling lowers significantly the odds that he or she trusts government, private industry or organization sources, or no "body", and "other" relative to a third-party source. Education has no significant effect on the choice of environmental or consumer sources relative to a third-party source.

As an individual ages, the odds he or she trusts an environmental or a consumer group or "nobody" falls significantly relative to trusting a third-party source. His or her age, however, has positive effect on the odds of trusting government, private industry or organization, or other relative to a third-party source. These effects, however, are statistically weak. If a participant reported in the preauction questionnaire that he or she was "informed about genetically modified foods," he or she is significantly more likely to trust the government relative to a third-party source. If a participant had a strict religious upbringing, he or she has significantly lower odds of trusting private industry or organization and higher odds of trusting "nobody" relative to a third-party source. The person's religious upbringing, however, did not have a significant effect on the odds of any of the other choices relative to third-party information.[6]

Conclusion and Implications

Although many organizations disseminate information on a wide range of topics, they must gain the trust of a constituent group before they can affect decisions. In the case of GM foods, the international environmental NGOs and agricultural biotech industry disseminate conflicting information. International environmental NGOs disseminate negative information; agricultural biotech industry disseminates positive information. In fact, the international environmental NGOs, agricultural biotechnology industry, and U.S. government all have different interpretations of the role of GM foods should play in our society. Hence, the federal government is not a valid third-party source, for example, some groups are not in favor of the FDA policies

[6] Multinomial logit models including a participant's gender and marital status were also fitted. These variables did not have estimated coefficients that were statistically different from zero at the 5% significance level.

on voluntary GM food labels, but a quasi-governmental entity funded by the government and staffed with informed but financially disinterested scientists not answering to the government may be the best possible source to provide information on foods labeled as GM.

Although the literature on the economics of trust is growing rapidly, few studies have examined the contribution of an individual's PC and SC to his or her trust. This article has provided new econometric evidence that PC and SC of adults who are consumers affect significantly their trust in five different sources of information on genetic modification relative to an independent, third-party source. We have shown that an individual's PC—schooling, age, religion, and self-reporting status as being informed about GM foods—and SC in religious affiliation contributed significantly to explaining the odds of particular information source preferences.

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